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were stationed by the author on the summit of Sca-Fell Pike. He states that from the maximum thermometer no correct readings could be obtained; but that the minimum gave the following:—July, 22°; August, 24°; September, 18°; October, —6°; November, —6°; December, —9°. It appears that on the night between the 2nd and 3rd of January the minimum thermometer indicated the extraordinary low temperature —34° Fahr.: at the same date a naked thermometer on grass at Whitehaven fell to +4°, and one on raw wool to —2°·8.

The author states that the results obtained from the mountain gauges during the last year, are in strict accordance with those of the two preceding years, and thus confirm the correctness of the conclusion drawn from them in his former paper, “that the quantity of rain increases from the valley upwards to an altitude of about 2000 feet, above which it begins to diminish.” He does not, however, by any means infer that the law which appears to regulate the distribution of rain in the mountain district of Cumberland will equally apply to every similar locality.

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April 26, 1849.

The EARL OF ROSSE, President, in the Chair.

A paper was read, entitled “A Report upon further Observations of the Tides of the English Channel made by order of the Lords Commissioners of the Admiralty in 1848, with remarks upon the Laws by which the Tidal Streams of the English Channel and German Ocean appear to be governed.” By Captain F. W. Beechey, R.N., F.R.S. Communicated by the Lords Commissioners of the Admiralty.

The author commences this report by observing, that the result of the observations upon the tides in the English Channel, made in the course of the summer of 1848, had confirmed in a satisfactory manner the view he had taken of the tidal phenomena of the channel, in the report communicated to the Royal Society last year, and printed in the Philosophical Transactions (Part I. 1848), namely, that there is a meeting and a separation of the streams between Alderney and the Start: that the whole space between the Start and Scilly is under the joint influence of the channel and offing streams: that from the vicinity of the Start to the vicinity of Hastings the stream runs true up and down the channel; and moreover that this stream throughout turns nearly simultaneously with the time of high and low water on the shore at the virtual head of the tide, which he places in the vicinity of Dover; and lastly, that the streams which meet off the Start are turned down into the Gulf of St. Malo, and *vice versâ*.

He then takes a comprehensive view of the tidal system of the English Channel and German Ocean together, and considering them as one great canal open at both extremities to the free admission of a great tidal wave, which might be supposed to meet and form a combined or stationary wave (art. 187, Encyclopedia Metropolitana), he infers that in such a case, there ought to be in the *eastern half* of such a canal, a recurrence of the phenomena which had been found to exist in the *western half*. He proceeds to explain that, from a valuable series of observations in the German Ocean by Captain Washington, R.N., and other authorities, it does appear that, inverting the direction of the stream, there is a correspondence of phenomena in almost every respect: that the offing and channel streams meet off Lynn, as off the Gulf of St. Malo, at the same hours, and at the same distance nearly from the virtual head of the tide: that the phase of the tide at Lynn corresponds with the phase of the tide at Jersey: that there is an increased rise there also; and that from the meeting of the tides off Lynn to the meeting of the streams off Dover, there is, as in the former case, a stream which turns nearly simultaneously with the high and low water on the shore at Dover; the incoming and outgoing streams coinciding with the rising and falling water there; and that there is, in fact, a complete identity of tidal phenomena in both parts of the supposed canal; of this an illustration is given in two plans.

The author states that the meeting of the waves which enter the canal at opposite points does not occasion a stationary point of permanent slack-water, but one wave alternately prevails, so that the point of slack-water oscillates between Ramsgate and Hastings nearly, and occasions an inversion of the stream at about two hours before that of the true stream of the channel. He thinks it convenient for the purposes of navigation to consider this an *intermediate* stream, although in reality it is only a shifting of the place of the meeting and divergence of the opposite channel streams. To illustrate this part of the paper a table is given, in which the courses of the streams in various compartments of the supposed canal are given at every hour of the tide.

The author thinks this system of tides sufficiently established for the purposes of navigation, but with regard to the perfectly simultaneous motion of the stream throughout the stationary wave, he is of opinion that nothing but simultaneous observations will be considered satisfactory to science upon such a point, and these he hopes will be supplied by the observations of the ensuing summer.

The advantage of referring the motion of the stream to a standard such as that of the Dover tide-table will, it appears, be sensibly felt by the mariner, who will now have his course through the moving waters of the channel rendered simple and plain, instead of being perplexed with unsatisfactory references, and with calculations which in too many instances, it is believed, have caused the set of the tide to be wholly disregarded.

The want of a standard to which desultory observations, made in

various parts of the channel, could be referred, the author believes to have been the occasion of several erroneous impressions of a tendency somewhat dangerous to navigation. As such he considers the following :—that the tide in all parts of the channel partakes of a rotatory motion and is never at rest, and that a ship's reckoning will never be far out in consequence, as she will never be carried far in one direction : that a vessel arriving off the Start at low water could, by sailing seven or eight knots an hour, carry ten or eleven hours' favourable tide to Beachy Head : that in the German Ocean the stream sets north-east on one side, whilst it is running south-west on the other : that there is a tide and half-tide in the channel, so that when the stream has done in shore, by standing out, a ship will carry the stream three hours longer, or nine hours in one direction : and lastly, that the stream runs strongest at high and low water throughout the channel, and is motionless at half-tide.

These impressions do not appear to be justified by the observations. The stream, when not diverted by rivers or estuaries, appears to run true up and down the channel, and from side to side nearly ; between the Start and Hastings, in the English Channel, scarcely varying a point for nearly five hours ; and in the German Ocean for about four hours ; the varying of the stream there being due, in the author's opinion, to the influence of the Thames and the rivers of Holland. As the stream turns nearly with the high and low water on the shore at Dover, there cannot be nine hours' current in one direction. With regard to the time at which the stream attains its greatest strength, he states that all the observations agree in fixing it at about half-tide (Dover).

The erroneous impressions above mentioned, the author considers have arisen from the times of the observations when made having been referred to the times of high water at places differing *two or three hours* from the time of high water at the *head of the wave*, or from an early popular opinion that the turn of the stream in the offing coincides with the rise and fall of the water on the shore.

The paper concludes with some remarks on the forms of the tide-wave between Cromarty and the Land's End, which are exhibited in two plans at every hour of the tide, obtained from a combination of the ranges and establishments of Dr. Whewell with those of M. Chazallon ; and attention is particularly drawn to the relative lengths of the *stationary wave* and the *waves* by which it is *generated* ; the *former* wave being only *half the dimensions of the latter*. These forms are exhibited on a reduced scale, but much exaggerated in height, and afford a comparison between the curve assumed by the stationary wave and that which the waves would have assumed had they rolled on in an uninterrupted course.

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His Grace the Lord Archbishop of Canterbury, and the Right Honourable Lord John Russell, were admitted into the Society on January 25, 1849.